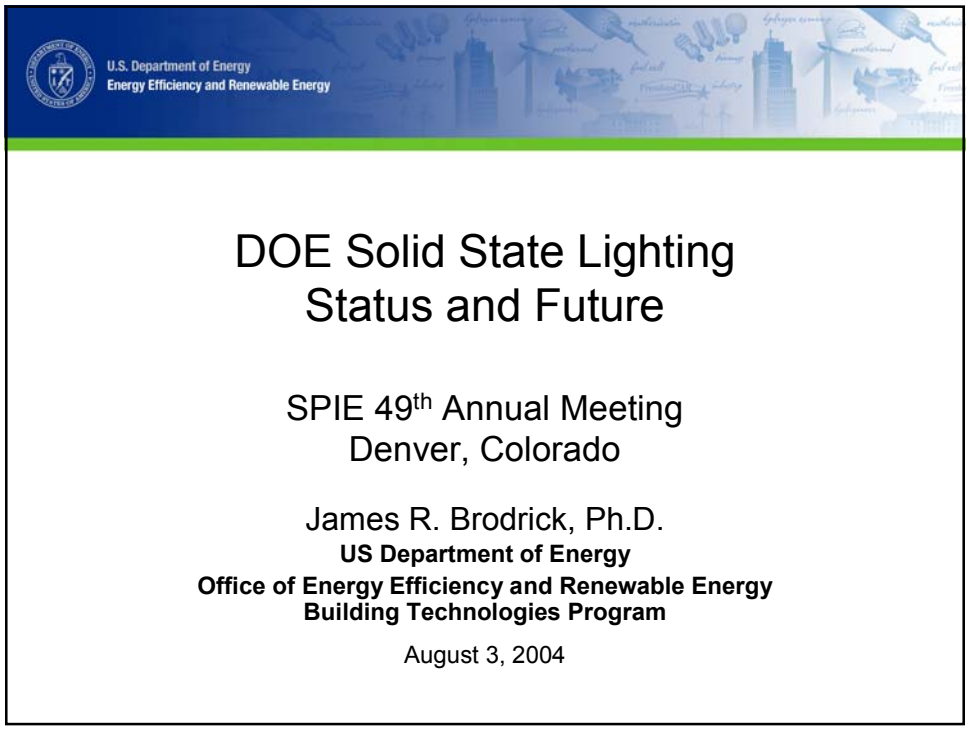
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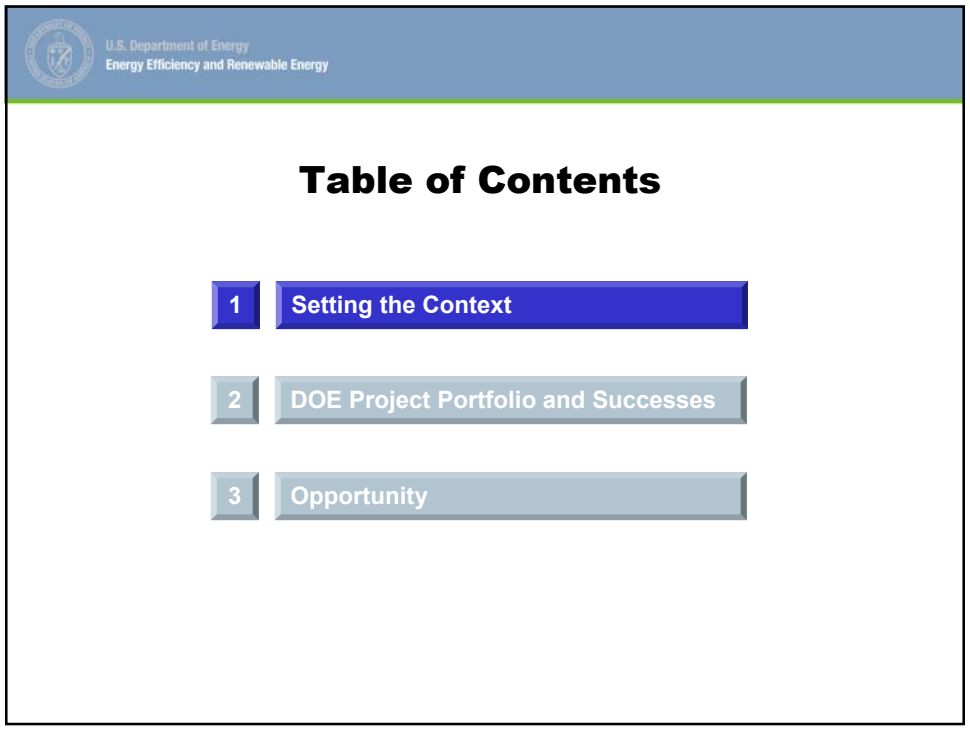
Energy Efficiency and Renewable Energy
DOE Solid State Lighting
Status and Future
SPIE 49th Annual Meeting
Denver, Colorado
James R. Brodrick, Ph.D.
US Department of Energy
Office of Energy Efficiency and Renewable Energy
Building Technologies Program
August 3, 2004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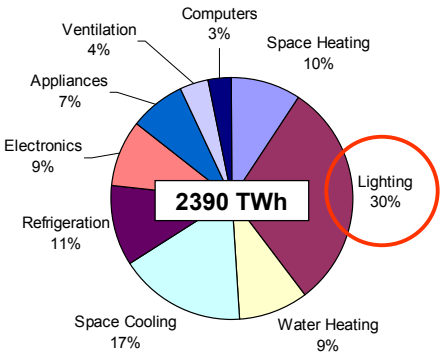
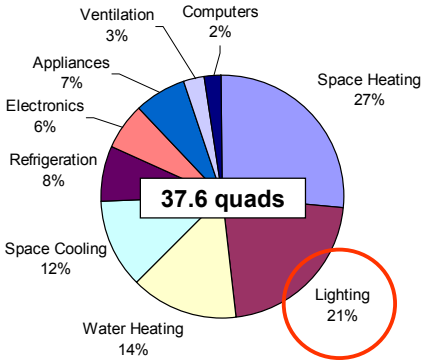
U.S. Buildings Energy End-Use Breakdown, 2001

Site Electricity Consumption



Total Primary Energy (all fuels)



Source: Building Technology Program Core Databook, August 2003. http://buildingsdatabook.eren.doe.gov/frame.asp?p=tableview.asp&TableID=509&t=xls

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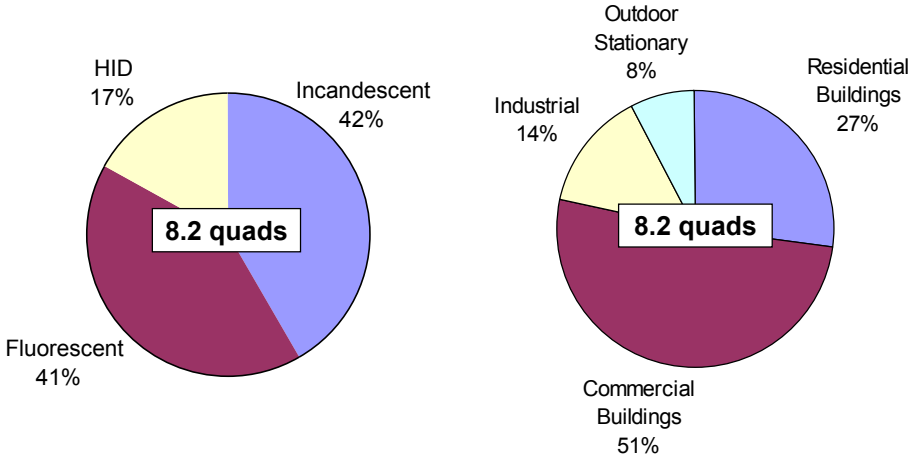
U.S. Energy Consumption for Lighting, 2001



Quantity of primary energy consumed to provide electricity for lighting.

Source: U.S. Lighting Market Characterization Volume I — National Lighting Inventory and Energy Consumption Estimate, Navigant Consulting, September 2002.

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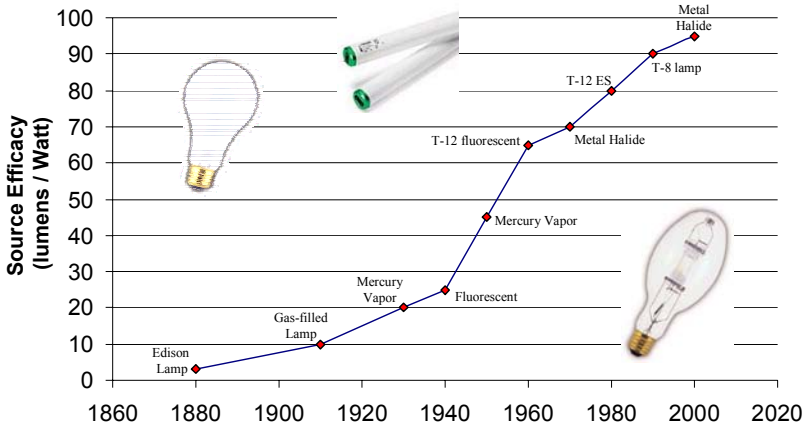
Historical Efficacy Improvement of White-Light Sources



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Typical Light Sources Today

Source efficacy (2003)

- Incandescent (75W) ~13 lm/W
- Fluorescent (T8) ~83 lm/W
- HID (Metal Halide) ~100 lm/W

Normalized retail lamp price (2003)

- Incandescent (75W) ~0.60 $/klm
- Fluorescent (T8) ~0.73 $/klm
- HID (Metal Halide) ~1.27 $/klm

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Examples of SSL Applications Today

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Efficiency and Cost of White Light Sources

Source efficacy (2003)

- Incandescent (75W) ~13 lm/W
- Fluorescent (T8) ~83 lm/W
- HID (Metal Halide) ~100 lm/W
- SSL (White LED) ~20 lm/W

Normalized retail lamp price (2003)

- Incandescent (75W) ~0.60 $/klm
- Fluorescent (T8) ~0.73 $/klm
- HID (Metal Halide) ~1.27 $/klm
- SSL (White LED) ~250.00 $/klm

Research is is improving SSL efficacy while decreasing price

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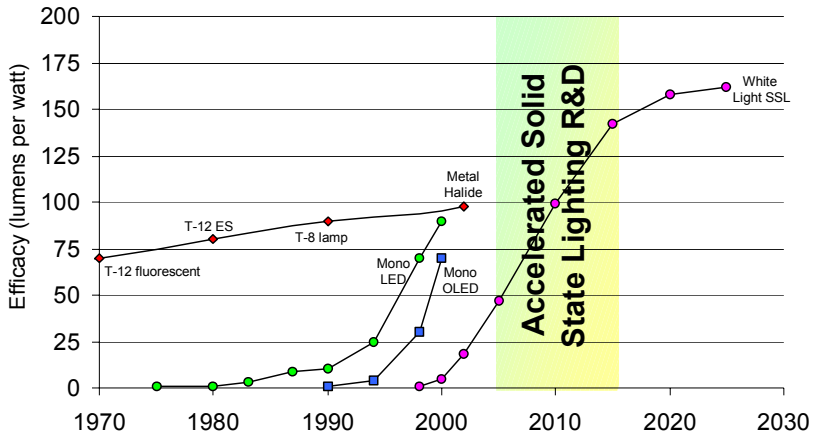
Accelerated R&D for White Light SSL



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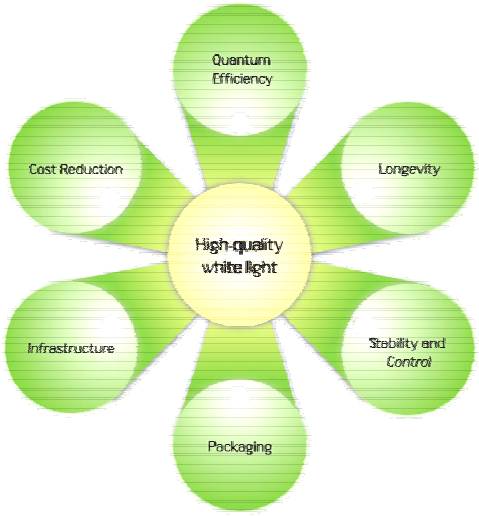
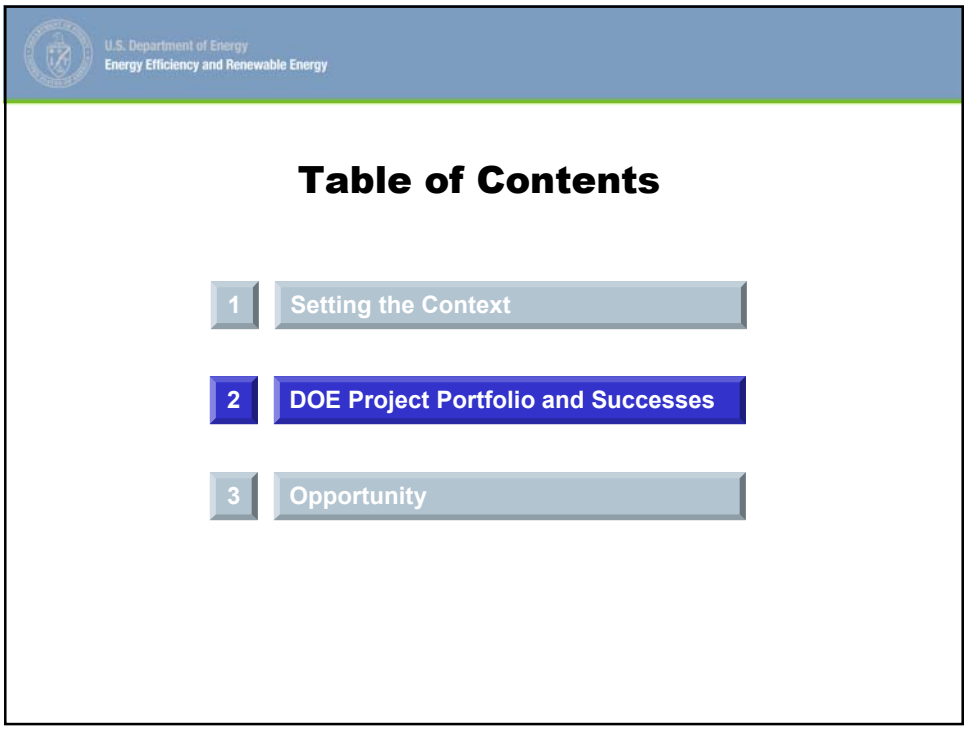
SSL Research Facets to Achieve White Light

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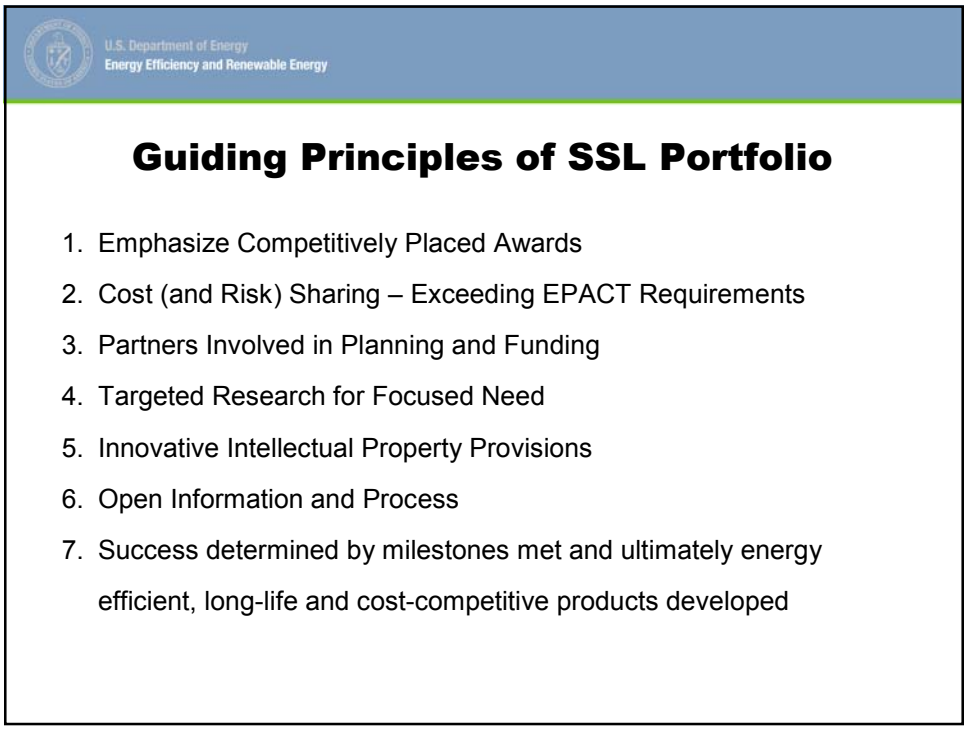
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Guiding Principles of SSL Portfolio
1. Emphasize Competitively Placed Awards
2. Cost (and Risk) Sharing – Exceeding EPACT Requirements
3. Partners Involved in Planning and Funding
4. Targeted Research for Focused Need
5. Innovative Intellectual Property Provisions
6. Open Information and Process
7. Success determined by milestones met and ultimately energy efficient, long-life and cost-competitive products developed

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SSL Program Planning

- Industry, national laboratories, and academics participate in R&D agenda planning process
  - Oct 2000, Albuquerque, NM. LEDs for general illumination.
  - Nov 2000, Berkeley, CA. OLEDs for general illumination.
  - Apr 2002, Berkeley, CA. OLED technical workshop to refine targets, challenges and approaches.
  - May 2002, Albuquerque, NM. LED technical workshop to refine targets, challenges and approaches.
  - Nov 2003, Crystal City, VA. Planning workshop on LEDs and OLEDs to review and prioritize DOE's SSL R&D portfolio
- Stakeholder consultation and participation are integral to the SSL R&D agenda planning process
- Workshop reports are available online: http://www.netl.doe.gov/ssl/

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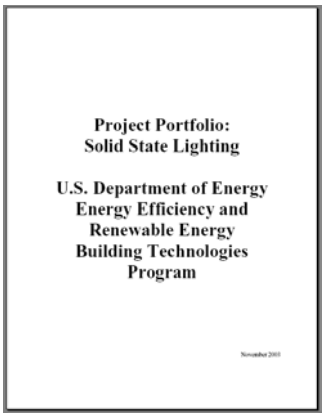
Research Project Summary

- **Over 25 active research projects**
  - See report from November 2003
  - New projects added to portfolio
  - Projects completed
- **High degree of stakeholder interest**
  - 2003 solicitations, ~ 100 applications received
  - Similar levels of interest in 2004



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Sample Results: Lumileds and Sandia National Laboratory

- Investigate critical materials issues
- Use of semiconductor nanoparticles ("quantum dots") as luminescent down-converting materials for white LEDs.
- Nanoparticles achieved quantum efficiencies up to 76 percent, a world record.

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Sample Results: General Electric and Cambridge Display Technologies

- Practical-sized OLED light panel that produces white-light
- Targeted 1200 lumens of quality white light with an efficacy of 15 lumens per watt
- Specification similar to today's incandescent lamp technology
- Broke two world records

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Sample Results: Cree Lighting Company

- Improve LED package efficiency and brightness through the development of new structures and materials
- Produced the most efficacious white-light LED laboratory device at 74 lumens per watt
- On par with some fluorescent lighting systems and more than four times more efficient than incandescent sources

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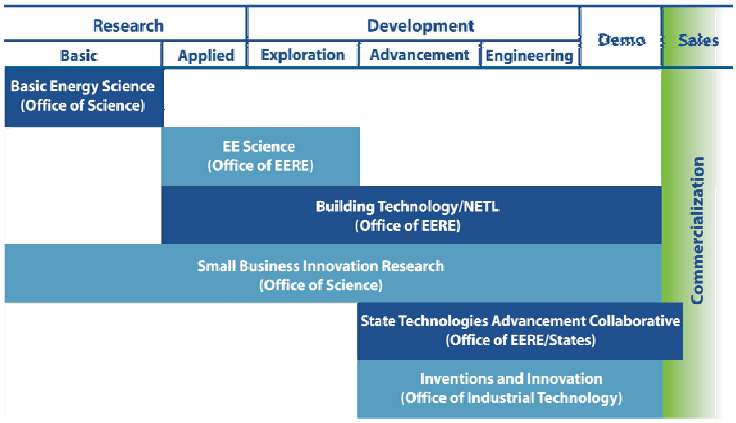
DOE Funding Opportunities



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DOE Funding Opportunities

- Office of Science, Annual Solicitation Process
  http://www.science.doe.gov/grants/Fr04-01.html
- Office of Energy Efficiency and Renewable Energy, Science Initiative
  http://www.naseo.org/stac/
- Office of Energy Efficiency and Renewable Energy, Energy Efficient Building Equipment and Envelope Technologies IV
  http://www.netl.doe.gov/business/
- Office of Science, Small Business Innovation Research
  http://sbir.er.doe.gov/sbir
- Office of Energy Efficiency and Renewable Energy / States, State Technologies Advancement Collaborative (STAC)
  http://www.naseo.org/stac/default.htm
- Office of Industrial Technology, Inventions and Innovation
  http://www.oit.doe.gov/inventions/solicitations.shtml

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Recent / Current Solicitations

Jan 2004	Small Business Innovation Research (SBIR) Program
Feb 2004	Core Technology: Lab Call for Applied Research
Mar 2004	Core Technology: Industry Solicitation for Applied Research
May 2004	Product Development: Industry Solicitation
May 2004	SSL Partnership Solicitation

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Future Events

- Solicitations and Meetings
  - Sept 2004: SBIR Solicitation
  - Jan – Feb 2005: SSL Program Planning Meeting
  - 2005: Core Technology Solicitation
  - 2005: Product Development Solicitation
- Website: http://www.netl.doe.gov/ssl

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Illuminating Ideas

- DOE engages community in an open, competitive process
- Sharing of risk
- Initial R&D projects produced success
- Improve price and performance of white light SSL devices
- National energy security and benefits